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RESULTS OF TESTS WITH DDT AGAINST COTTON INSECTS IN 1944

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The results of tests^{1/} conducted with DDT (1-trichloro-2,2-bis-(p-chlorophenyl)ethane) during 1944 for the control of insects attacking cotton are briefly summarized in this paper. The DDT was obtained in two forms--(1) 10 and 50 percent factory mixtures with pyrophyllite and (2) a technical grade. The DDT-pyrophyllite mixtures were further diluted with pyrophyllite to the desired strength or mixed with other insecticides, and the technical DDT was pulverized and mixed with sulfur in a local commercial hammer mill. In the tests where more than one application was made, the treatments were applied at 4- or 5-day intervals except as otherwise indicated.

DDT in the formulations used was of no practical value for control of the boll weevil (Anthonomus grandis Boh.) or the cotton leafworm (Alabama argillacea (Hbn.)), and caused increases of the cotton aphid (Aphis gossypii Glov.) and the common red spider (Tetranychus sp.). It was effective against the pink bollworm (Pectinophora gossypiella (Saund.)), the bollworm (Heliothis armigera (Hbn.)), the cotton flea hopper (Psallus seriatus (Reut.)) and several other mirids, the stinkbugs (Chlorochroa sayi Stål, C. ligata (Say), Euschistus impictiventris Stål, and Thyanta custator (F.)), the onion (Thrips tabaci Lind) and tobacco thrips (Frankliniella fusca (Hinds)), and the beet armyworm (Laphygma exigua (Hbn.)). The results against the pink bollworm were especially encouraging, since no satisfactory insecticidal control for this insect was previously known. There was no indication of injury by DDT to the cotton plant. Additional work is needed on methods of formulation and application, especially for concentrated sprays and means of preventing an increase of aphids.

^{1/}The experiments at Tallulah, La., were conducted by R. C. Gaines, M. T. Young, G. L. Smith, and G. L. Garrison; at Waco, Bryan, and Port Lavaca, Tex., by K. P. Ewing, R. W. Moreland, E. E. Ivy, C. R. Parencia, Jr., and A. B. Beavers; at Brownsville and Raymondville, Tex., by A. J. Chapman, L. C. Fife, R. L. McGarr, Ivan Shiller, C. A. Richmond, O. L. Walton, W. T. Wellhouse, and Ignacio Moreno; at Presidio, Tex., by L. W. Noble, J. C. Clark, O. T. Robertson, and M. H. Hughes; at Tucson and the other places in Arizona, by W. A. Stevenson, L. W. Sheets, J. M. Breazeale, and William Kauffman.

Boll Weevil

In cage and plot tests DDT dust was not so effective as calcium arsenate against the boll weevil.

In tests on caged plants the percent mortalities were as follows: At Tallulah, La., 34 from 2.5 percent DDT, 48 from 5 percent DDT, 75 from 10 percent DDT, and 84 from calcium arsenate; at Waco, Tex., 9 from 2 percent DDT and 16 from 10 percent DDT both applied at 16 pounds per acre, and 78 percent from calcium arsenate at 8 pounds per acre.. In plots at Tallulah five applications of 5 percent DDT dust failed to reduce the weevil infestation below that of the checks. In another experiment the addition of 2.5 percent DDT to calcium arsenate did not increase the effectiveness or produce so much cotton as the calcium arsenate treatment. In other field tests at Waco, Bryan, and Port Lavaca, Tex., where DDT in pyrophyllite or mixtures of pyrophyllite and sulfur were used for other insects, the boll weevil infestation was extremely low but was not appreciably reduced by the DDT.

Cotton Leafworm

DDT was not effective against the cotton leafworm.

At the Waco laboratory the median lethal dosage of a water suspension of DDT applied to the dorsa of fifth-instar leafworms was determined as 61.5 mg. per gram of body weight or 206 times as great as the median lethal dosage of 0.299 mg. for the bollworm. In field tests 3 or more applications of approximately 16 pounds per acre of 1, 2, 4, and 8 percent DDT dust applied with hand dusters at Waco and 4 percent DDT dust applied by airplanes at Bryan failed to prevent defoliation of plants. Field plots at Tallulah were defoliated following 5 applications of 5 percent DDT dust. At Presidio, Tex., where 8 to 10 heavy dust applications were made for the pink bollworm, DDT gave considerable control of the leafworm, particularly the smaller larvae. In tests at Waco cotton plants sprayed 6 times with a water suspension of DDT at the rate of 0.64 pound of the active ingredient per acre-application caused a greater reduction of leafworms than plants dusted with the same dosage, but neither treatment prevented almost complete defoliation.

Cotton Aphid

DDT was not effective against the cotton aphid and seemed to cause about the same increase in aphids as did calcium arsenate, under the conditions of light aphid infestations that prevailed in 1944.

In field experiments at Tallulah, Waco, and Bryan, the aphid populations in plots dusted 3 to 6 times with DDT were about equal to those in the plots similarly dusted with calcium arsenate. The addition of 2.5 percent DDT to the calcium arsenate used in an experiment at Tallulah caused a greater increase in aphids than undiluted calcium arsenate or 5 percent DDT in pyrophyllite, but where 1 percent of nicotine was added to the DDT-calcium arsenate the aphids were held in check. However, at

Brownsville the aphid build-up in plots receiving 7 effective applications of 10 percent DDT dust was significantly lower than in plots treated with calcium arsenate or a mixture of calcium arsenate and DDT-pyrophyllite, and at Presidio 10 applications of 10 percent DDT dust did not cause a damaging aphid population to develop.

In a large-scale experiment at Waco sweeping records during the dusting period showed that populations of ladybird adults and larvae were reduced about 67 percent in the DDT plot and 70 percent in the calcium arsenate plot. At Tallulah these predators were reduced about 75 percent in the field plots dusted with 5 percent DDT and 83 percent in the calcium arsenate plots.

Red Spider

Observations in plots at Tallulah and Brownsville dusted with DDT indicated that red spiders were increased somewhat by the treatment but did not become sufficiently abundant to cause damage.

Bollworm

DDT was effective against the bollworm.

In tests on caged cotton plants at Waco dusts tested against the laboratory-reared third-instar bollworms gave the following percent mortalities: 84 from 4 percent DDT and 73 from a 1:1 mixture of basic copper arsenate-sulfur, both applied at 16 pounds per acre, as compared with 62 from calcium arsenate, 65 from lead arsenate, and 66 from cryolite (88 percent sodium fluoaluminate), each at 8 pounds per acre. In a similar series of cage tests the percent mortalities resulting from various strengths of DDT dusted at 16 pounds per acre were as follows: 85 from 4 percent, 71 from 2 percent, 37 from 1 percent, and 25 from 0.5 percent. An equal quantity of DDT (0.32 lb. per acre) applied as a heavy poundage of a low concentration dust was more effective than a light poundage of a higher concentration; that is, 32 pounds of 1 percent DDT was more effective than 16 pounds of 2 percent, 8 pounds of 4 percent, or 4 pounds of 8 percent DDT. Four percent of DDT in pyrophyllite was only slightly more effective when used with calcium arsenate than when used alone. A spray application (water suspension) of 0.64 pound of DDT per acre did not kill so quickly as the same amount applied as a dust but was nearly equal in effectiveness by the fourth or fifth day. After four applications the residual effect was slightly greater from the sprays than from the dusts. Water sprays at the rate of 1.28 pounds of DDT per acre caused 100 percent mortality of third-instar bollworms, at 0.64 pound of DDT 89 percent, at 0.32 pound 66 percent, and at 0.16 pound 45 percent.

In a field experiment at Waco on 1/10-acre plots with four replicates, two effective dust applications of DDT at 16 pounds per acre-application resulted in the following gains in pounds of seed cotton per acre: 148 from 1 percent DDT; 154 from 2 percent, 238 from 4 percent, and 230 pounds from 8 percent DDT. Calcium arsenate at the same rate per acre-application gave a gain of 273 pounds per acre. The 4 and 8 percent DDT and the calcium arsenate treatments were significantly better than the check.

In a large-plot (unreplicated) experiment at Bryan four applications of a 4 percent DDT-pyrophyllite dust at 16 pounds per acre-application gave a gain of 736 pounds of seed cotton per acre in comparison with 688 pounds from calcium arsenate at 15 pounds per acre-application.

Pink Bollworm

DDT is the most promising material that has been tested against the pink bollworm.

At Presidio DDT, cryolite, and mixtures of the two were compared on 1/5-acre plots with four replicates in randomized blocks. (There were originally six replicates, two in each of three fields, but one was flooded on August 23, after five applications had been made, and was dropped from the experiment. The other two fields were flooded on September 13 after eight applications and no yield records were obtained.) Dust applications of approximately 15 pounds per acre were started when the oldest bolls were large enough for the pink bollworm to attack, and were repeated at approximately 5-day intervals. The percent reduction in the larval population in the bolls after eight applications was 53 from 2.5 percent DDT, 78 from 5 percent DDT, 88 from 10 percent DDT, 62 from DDT-pyrophyllite-cryolite (2.5:22.5:75), 61 from DDT-pyrophyllite-cryolite (5:45:50), and 44 from cryolite alone.

In another test at Presidio a 6-acre field was dusted with 10 percent DDT at 15 pounds per acre beginning on August 29 when 35 percent of the bolls were infested. Dusting was discontinued on 2½ acres of this field on September 16 after 4 applications had been made, but was continued on 3½ acres until 8 applications had been made by October 12. On this date there was an average of 12 pink bollworms per green boll in the check, 8.3 per boll, or a reduction of 31 percent in the part receiving 4 applications, and only 0.73 pink bollworm per boll, or a reduction of 94 percent, after 8 applications. Late bolls in the section of the field dusted 8 times were not damaged sufficiently to affect the grade of the cotton, whereas in the check they were severely damaged.

In tests at Brownsville where moths were caged on plants heavily dusted with DDT, no larvae developed in the bolls. In similar tests with smaller dosages of 5, 10, and 20 percent DDT applied at the rates of 5/8 to 3 pounds of the mixture per acre, the reduction in larvae ranged from 25 to 81 percent. Small larvae crawling over a dust film of 10 percent DDT were extremely irritated but not killed, indicating that the reduction in population might have been due to killing the moths before oviposition occurred.

Cotton Flea Hopper

DDT was effective against the cotton flea hopper. Several concentrations and combinations of DDT were compared with sulfur and the standard 1:2 mixture of calcium arsenate and sulfur for control of this insect.

At Port Lavaca, on heavily infested plots dusted five times at the rate of 12 to 13 pounds per acre, 2 percent DDT gave a reduction in

population about equal to that given by the 1:2 calcium arsenate-sulfur mixture, but the yields were significantly better than from this mixture, or from either 1 or 0.5 percent DDT.

At Raymondville and Brownsville, on heavily infested plots dusted once, the reduction in flea hopper populations in 4 to 6 days was about one-third greater from 2.5 and 5 percent DDT than from sulfur or 1:2 calcium arsenate-sulfur. The DDT also held down the populations for a longer period, indicating that the interval between applications of this material might be lengthened.

At Waco medium to heavily infested plots dusted four times showed no significant differences in population between 4 percent DDT-pyrophyllite, 2 percent DDT-pyrophyllite, DDT-pyrophyllite-sulfur (2:18:80), calcium arsenate-sulfur (1:2), and DDT-pyrophyllite plus (1:2) calcium arsenate-sulfur (2:18:80). The yield from each treatment was greater than from the check, and from the 2 percent DDT-pyrophyllite significantly greater than from the calcium arsenate-sulfur but not significantly better than from the other treatments containing DDT.

Plant Bugs and Stinkbugs

DDT was effective against plant bugs and stinkbugs.

In tests on caged plants at Mesa, Ariz., 2.5, 5, and 10 percent DDT gave excellent kill of the mirids Lygus oblineatus (Say), Lygus spp., Adelphocoris superbus (Uhler), and Creontiades femoralis Van Duzee, and the stinkbugs Chlorochroa sayi Stål, C. ligata (Say), Euschistus impictiventris Stål, and Thyanta custator (F.). A high mortality of tarnished plant bug (Lygus oblineatus (Say)) adults was also obtained with the same materials in cage tests at Tallulah, La.

In field tests the results against the tarnished plant bug were somewhat erratic and control was not so consistent as in the cage tests. Control of mixed populations of the tarnished and rapid plant bugs (Adelphocoris rapidus (Say)) in field plots at Tallulah was poor in most instances from six dust applications of 2.5 or 5 percent DDT. Field tests in Arizona in which DDT was applied by hand dusters, power dusters, and airplanes at weekly intervals for control of mixed populations of several species of plant bugs and stinkbugs indicate that DDT-pyrophyllite-sulfur dust will give better results than the arsenical-sulfur mixtures. In a small-plot Latin-square experiment dusted with hand guns at Mesa, seven applications of DDT-pyrophyllite-sulfur (4:36:60) resulted in a gain of 1,018 pounds of seed cotton per acre, or 42 percent more than the check, as compared with 13 to 26 percent from four arsenical-sulfur mixtures. At Litchfield Park, Ariz., a heavily infested 18-acre field dusted six times by airplane with DDT-pyrophyllite-sulfur (4:36:60) produced a gain of 920 pounds of seed cotton per acre, or 97 percent more than the check and 30 percent more than an adjacent 58-acre field dusted with paris green-sulfur (15:85). At Marana, Ariz., a lightly infested 20-acre field dusted once by airplane late in the season with 2 percent DDT produced 17 pounds of seed cotton per acre less than the 20-acre check. At Buckeye, Ariz., three heavily infested



1-acre plots dusted seven times with DDT by power duster produced 551 pounds gain as compared with 396 pounds from paris green-sulfur (7.5:92.5), and a loss of 22 pounds from 1 percent dinitro-o-cresol. The dust used in this experiment contained 2 percent of DDT in pyrophyllite for two applications, DDT-pyrophyllite-sulfur (4:36:60) for three applications, and 5 percent DDT-pyrophyllite for two applications. Cage and field tests indicate that 2 percent DDT was not so effective as 4 or 5 percent DDT and the addition of sulfur to the DDT dusts caused a quicker kill of plant bugs and stinkbugs.

Thrips

In small-plot tests at Brownsville for control of Thrips tabaci Lind. on onions, the population was significantly reduced 24 hours after treatment with 2.5, 5, and 10 percent DDT dust applied at rates from 0.21 to 1.70 pounds of DDT per acre. While the population decreased with the increase in quantity of DDT applied, there was no significant difference in the reduction obtained when 0.50 pound or more per acre was used.

In small-plot tests conducted in 1943 one application of a 3 percent DDT dust gave very good kill of a heavy infestation of Thrips tabaci Lind. and Frankliniella fusca (Hinds) on cotton.

Beet Armyworm

In tests on caged plants at Tucson and Mesa, Ariz., 2 percent DDT gave excellent results against the beet armyworm.

Small Darkling Beetle

In one cage test at Tucson, Ariz., 100 percent kill of Blapstinus auripilis Horn was obtained in 67 hours with 2 percent DDT.